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Marine Biological Station  
Millport

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SEVENTEENTH ANNUAL REPORT

1st August 1986-31st July 1987

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### **Committee of Management**

#### **Ex-officio:**

The Principal of the University of Glasgow  
(Sir Alwyn Williams, Ph.D., D.Sc., LL.D., F.R.S., F.R.S.E.)  
The Principal of the University of London  
(Mr. P. Holwell, B.Sc. (Econ), M.B.C.S., F.C.A.)  
The Director of the University Marine Biological Station Millport  
(Professor J.A. Allen, Ph.D., D.Sc., F.I.Biol., F.R.S.E.).

**Chairman:** R.J.H. Beverton, C.B.E., F.I.Biol., F.R.S.,  
Professor of Fisheries Science, UWIST.

#### **Members nominated by the University of Glasgow:**

M.C. Keen, B.Sc., Ph.D., Lecturer in Geology  
P.S. Meadows, M.A., Senior Lecturer in Zoology  
A.C. Wardlaw, Ph.D., D.Sc., F.R.S.E., Professor of Microbiology  
M.B. Wilkins, Ph.D., D.Sc., F.R.S.E., Regius Professor of Botany  
and Dean of Science.

#### **Members nominated by University of London:**

M.G. Audley-Charles, B.Sc., Ph.D., Professor of Geology,  
University College  
R.P. Dalcs, B.Sc., Ph.D., Professor of Zoology, Royal Holloway and  
Bedford New College \*  
P.J. Peterson, M.Sc., Ph.D., Professor of Environmental Biology,  
King's College (KQC)  
V. Moses, Ph.D., D.Sc., Professor of Microbiology, Queen Mary College

#### **Other Members:**

J. Addy, B.A., Ph.D., Head, Environmental Sciences Group, Britoil, plc.  
G.M. Dunnet, B.Sc., Ph.D., F.I.Biol., F.R.S.E., Regius Professor of  
Natural History, University of Aberdeen  
J. Hind, General Manager, Offshore Division, J. Marr Ltd., Hull.  
J.R. Stewart, C.B.E., M.A., LL.D.

**Secretary to the Committee of Management:** Mr. D.J. Murden

\* Nominated in consultation with the Academic Advisory Board in Science

### Introduction

The University Marine Biological Station Millport is an institution of the Universities of London and Glasgow with the defined objects of providing facilities for teaching and research in marine biology, primarily, though not exclusively, for the two Universities and of providing supplies of marine biological material for the universities of the U.K.

It is well sited to do so, being situated on the Isle of Cumbrae in the Firth of Clyde, an area providing easy access to an exceptionally rich marine fauna and flora. The buildings border on the shore which is immediately accessible and are near the classic sandy and boulder beaches of Kames Bay and Ballochmartin Bay, both of which have been designated 'Sites of Special Scientific Interest' by the Nature Conservancy Council. The other rocky, sandy or shingle beaches of the eleven-mile perimeter of the island are readily accessible from the coast road which passes the Station as, too, are many small marshes each with a rich flora. Access to the Station's research vessels is obtained by Keppel Pier which lies opposite and is owned by the Station.

### History

Marine biological studies on the island stem from the 1840's when the 'Cumbrae Naturalist' David Robertson was a frequent visitor. Later, he settled in the town of Millport and worked on the Ark, a floating laboratory moored on the East side of Kames Bay. The Ark, owned by Sir John Murray, had been towed to Millport from Granton by means of his steam yacht Medusa from which dredgings were carried out. Eventually, Dr. Robertson and a group of friends combined to build a permanent laboratory, and, as a result, the foundations of the first of the present Station buildings were laid in 1896. This became the headquarters of the *Scottish Marine Biological Association* and remained so until 1970 when its headquarters were transferred to Dunstaffnage.

Following the post-war expansion of British Universities, their biologists - notably those of the University of London - found increasing difficulty in obtaining direct access to facilities by the sea. At the same time the steadily increasing demand for marine material for research, teaching and examination had generated widespread acute shortages. The impending departure of SMBA from Millport presented a problem to the University of Glasgow, which had a long-standing close association with the Station. In 1968 a Working Party of the University Grants Committee was formed to investigate the teaching of marine biology in Britain. As a result, the UGC decided to enable the University of London to take over the running of the Millport Station from the SMBA. Since it was essential to safeguard the particular interests of the University of Glasgow and indirectly those of other Scottish Universities, the two Universities entered into partnership to administer through a Committee of Management the Station in its new role from June 1970.

### Activities

The Station welcomes visitors, researchers, and students from all parts of the world. A summary of its facilities is given in the Station's brochure. This and further particulars can be obtained on application to the Director.

Laboratory accommodation is available as research and experimental rooms and three teaching laboratories, suitably serviced including a constant supply of sea water, projection facilities, fume cupboards, etc. One research room is adapted for working with radioactive substances. A comprehensive range of apparatus is supplied including microscopes, incubators, refrigerators, centrifuges, spectrophotometers, physiological and behavioural recording instruments, video recorders, cameras and apparatus for microtomy and photomicrography. Dark room and computing facilities are available, the latter with access to mainframes. There is a modern lecture hall seating 80+, which is exceptionally well equipped with modern teaching aids including video display computer terminal and remote controlled projection facilities.

Living accommodation is available in a hostel and an annexe alongside the Station as well as in self-catering apartments nearby.

The services of two research vessels are provided, operating trawls, dredges, plankton nets, lines, grabs and corers. They have observational facilities for students and are fitted with modern electronic and computerized instruments for navigation, track plotting, fish finding and depth recording. Outboard motor dinghies are also available, as are S.C.U.B.A. diving facilities, the latter including air compressors and recompression chamber.

Both undergraduate and postgraduate students are taught at the Station, the latter through teaching and research supervised by Station staff, the former by courses conducted by the Station staff or by visiting teachers. The courses cover a variety of topics including marine biology, ecology, behaviour, marine microbiology, advanced studies on selected marine invertebrates and extramural studies.

The Specimen Supply Division supplies the greater part of the needs of British Universities as well as other Institutes of higher education at home and abroad, for living and preserved marine biological materials. In addition, it supplies living material for the Aquarium which, together with the Robertson Museum, is open to the public on weekdays and all year round.

### Teaching

The number of students of all categories who were taught in the Station in 1986/87 was 1059. This the second highest figure in the Station's history is but a few less than the all time high (1108) of the previous year. As before, this figure does not include the diving groups which have used the Station's facilities.

Despite the fact that the cutbacks in University financial support have meant that those such as Aberdeen, who have fared badly, have been forced against their will to cancel field courses others have immediately filled the gap. As a result this year we have welcomed students of Manchester and Hull Universities as newcomers to the Station.

Significant changes are taking place in the pattern of teaching at Millport. Firstly, there has been a move away from using preserved specimens for dissection exercises in practical teaching for biological degrees on the main campuses, as a result the need to bring students into the field to observe the variety of types of organism in their natural environment has been

increasing steadily and only financial restrictions have prevented a very large expansion in this function. The Station situated in an area where a very great variety of plant and animal life is accessible in a wide variety of habitats is ideally placed to service this need. Secondly, there is evidence of an upsurge in extracurricular study of various kinds, catering for interested amateurs, teachers seeking refresher courses and professional research workers coming together in workshops. The Station is both acting host and contributing its own courses to meet this demand. This year has seen the opening of the new lecture hall (see p. 26) which has transformed our teaching ability and service, no longer do students have to double up for lectures in a laboratory with benches damp and cluttered from ongoing practical teaching. The lecture hall now means that we can far more effectively meet the increasing demand for seminar and small conference groups.

Once again, it should be recorded that these facilities are nothing without the dedication and care of Mr. A.E. Elliott and his staff in providing a superb service seven days a week with turn round times of less than a day to clean up after the class departure in the morning and then to prepare and meet the needs of the incoming new class in the afternoon.

The second M.Sc. course in 'Water Resource Management' which the Station teaches jointly with the Department of Human Environmental Science, King's College (KQC) took place and continued to prove to be an excellent course in concept and utility and certainly a course unique in the U.K. Other postgraduate teaching included contributions to the LSE M.Sc. course on the 'Law of the Sea', and the supervision of full-time singly and jointly supervised postgraduate research students.

In relation to the latter the following completed their studies and were awarded degrees as follows:-

- 1) Mr. A.P. Bedford, (Ph.D.): "Metazoan Detritivores and Underwater Decomposition Processes of Detached Sublittoral Macrophytes". (Supervisor Dr. P.G. Moore, U.M.B.S.M.).
- 2) Mr. G.F. Gale, (M.Sc): "Aspects of the Respiratory Physiology of the Swimming Crab Liocarcinus depurator (Linnaeus)". (Supervisors: Dr. R.J.A. Atkinson, U.M.B.S.M., & Dr. A.C. Taylor, Glasgow University).
- 3) Mr. P. M. Rhind, (Ph.D.) "Species of the Family Nuculidae (Bivalvia: Protobranchia) from the Deep Atlantic: their Taxonomy, Form and Function". (Supervisor: Professor J.A. Allen).
- 4) Mr. R.S.M. Smith, (Ph.D.): "The Biology of Larval and Juvenile Nephrops norvegicus (L.) in the Firth of Clyde". (Supervisor: Dr. R.J.A. Atkinson, U.M.B.S.M. & Mr. C. Chapman, D.A.F.S.).
- 5) Mr. J.I. Spicer, (Ph.D.): "Physiological Ecology of Selected Talitrid Amphipods". (Supervisors: Dr. A.C. Taylor, Glasgow University & Dr. P.G. Moore, U.M.B.S.M.).

As usual the Station provided facilities and specimens for a wide range of undergraduate and graduate students from other Institutions who use the Station as a base for their field work and/or experimental studies. We also

accepted a number of summer students who gain experience by helping in the various activities of the Station and at the same time provide technical and research assistance to various members of staff.

During the year 1986/87 the following visiting courses were accommodated:-

		Student/Staff
Ecology & Conservation Studies Society	16-23 August	18
Aberdeen University, (Dept. of Zoology)	25 Sept - 4 October	15/3
King's College (KQC) London (M.Sc. course)	28 Sept - 5 October	8/1
Dundee University (Biological Sciences)	29 Sept - 5 October	12/2
Napier College (Biological Sciences)	7-10 October	45/6
Conyers School, Yarm, Cleveland	11-17 October	
Egglescliffe School, Stockton-on-Tees	11-17 October	32/4
L.S.E. M.Sc. "Sea Use"	27 Oct- 7 November	16/2
Glasgow University (Dept. of Cell Biology)	7- 9 November	32/8
Glasgow University (Dept. of Zoology)	28-30 January	7/2
Glasgow University (French Dept)	6- 8 February	39/7
Glasgow University (Biochemical Society)	13-16 February	20/3
Napier College (Biological Sciences)	27 Feb- 1 March	20/2
Glasgow University (Dept. of Biochemistry)	11-13 March	50
Queen Mary College (Biological Sciences)	14-21 March	31/3
Queen Mary College (Biological Sciences)	14-21 March	19/2
Edinburgh University (Dept. of Zoology)	21-28 March	46/4
King's College (Dept. of Zoology)	28 Mar- 4 April	26/4
Royal Holloway/Bedford New Coll.(Dept. Botany)	28 Mar- 4 April	26/1
Napier College (Biological Sciences)	30 Mar- 3 April	8/3
Glasgow University (Dept. of Zoology)	13-17 April	2/2
Queen Mary College (Biological Sciences)	18-25 April	43/4
King's College (KQC) London (M.Sc. course)	21 April-21 May	8
Henry Fanshawe School, Dronfield, Sheffield	25-30 April	16/2
Manchester Polytechnic (Dept. of Biol. Sciences)	30 Ap- 7 May	41/3
Manchester University (Dept. of Environ. Biology)	7-11 May	31/7
Austin Friars School, Carlisle	7-14 May	4/1
Glasgow University (Dept. of Genetics)	14-16 May	42
Hull University (Dept. of Adult Education)	22-25 May	4/1
Mill Hill County High School, London	22-28 May	7/1
Stirling University (Dept. of Biol. Sciences)	29 May- 4 June	42/4
Glasgow College of Technology (Dept. of Biology)	5-12 June	21/3
Strathclyde University (Dept. of Bioscience and Biotechnology)	8-14 June	18/4
Wakefield District College	14-19 June	40/4
Newcastle Upon Tyne University (Dept. of Zool)	20-27 June	35/5
York University (Dept. of Biology)	29 June- 8 July	52/7
King Edward's School, Birmingham	8-14 July	18/3
Reading University (Dept. of Zoology)	8-17 July	24/4
Fulford School, York	14-20 July	14/2
Earlham School, Norwich	19-24 July	13/1

The Station's own undergraduate courses were attended by 101 students from the following Universities and Colleges:-

**Marine Microbiology - 29 August-10 September 1986**

University College London	1
Royal Holloway/Bedford New College	5
King's College London	10
Glasgow University	13
Goldsmiths' College	2
Queen Mary College	6
Birkbeck College	1
Free Universität, Berlin	1

**Marine Biology - 11-25 September 1986**

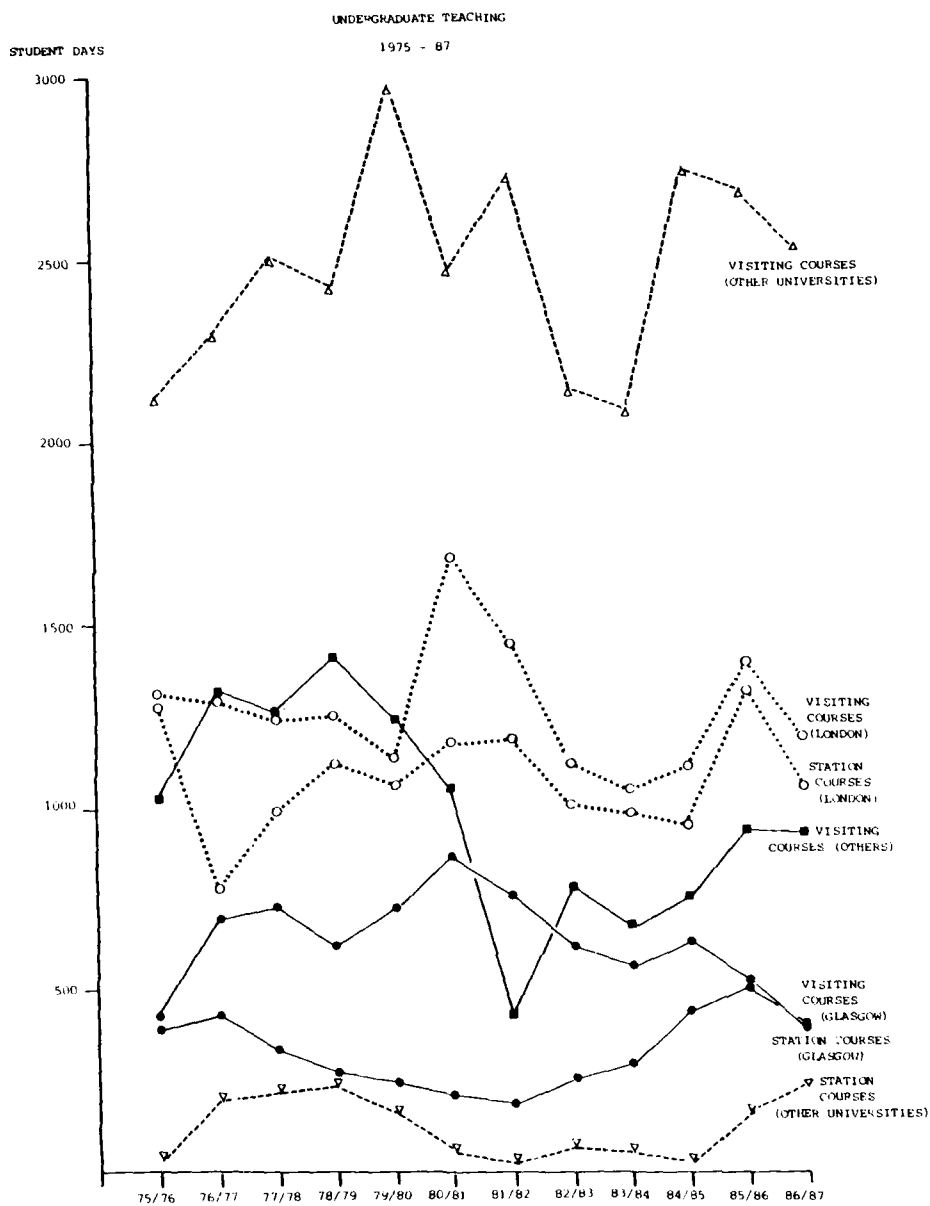
Royal Holloway/Bedford New College	9
University College Cardiff	8
University College London	8
Goldsmiths' College	4

**Marine Biology - 4-18 April 1987**

Glasgow University	15
Strathclyde University	7
Royal Holloway/Bedford New College	10
Sussex University	1

Dr. P.G. Moore assisted Dr. P.S. Rainbow in teaching a Queen Mary College field course at Orierton (Pembrokeshire) from 25th March-1st April, 1987. Station staff also provided a significant amount of teaching to various departments in Glasgow University, which in total amounts to the equivalent of a full lecturing load. This year we have been involved in the planning of a new degree in Aquatic Biology at the University of Glasgow and to which we are committed to making a substantial contribution. This must be placed in the context of an upsurge in debate on course content in relationship to changing demands to meet national trends and needs, which takes into account priorities and ability of Universities to teach particular subjects. Thus, the Director has been involved with other heads of departments in Scotland and elsewhere in discussing the future needs in Marine Science, to ensure that the teaching at the Station not only reflects these needs but complements rather than duplicates that elsewhere. There is heightened awareness and co-operation and the Station clearly plays an essential role that is particular to itself, yet is part of the overall needs of marine science at large.





### Diving

The number of dives undertaken by visitors has increased by over 150 this year, and the number of dives by Station staff and students (569) is the highest number ever recorded. This is the fifth year running that 'in-house' diving has increased. An average of 29+ dives per week over the year reflects the importance of the facility and records show that there has been a continuous demand throughout the year. A limited amount of advertising has been tried for the first time. While this has resulted in a number of queries, it is too early to predict a significant increase in bookings.

During the year extra-mural courses in marine biology for divers were organized and run by the chief diving technician and his wife Dr. Fiona Lonsdale. Although advertised only by 'word of mouth' these have been very well received and supported, and resulted in several new groups using the Station.

Mr. Thomas Nickell, a postgraduate student, having completed the required training and passed examinations, was awarded the World Underwater Federation's 3 star diving qualification.

An initial diving contract was undertaken for NCC to study the benthic fauna at Loch Sween and this will be followed by a second contract. We hope that this is a forerunner of this type of work and to which we are well qualified to respond.

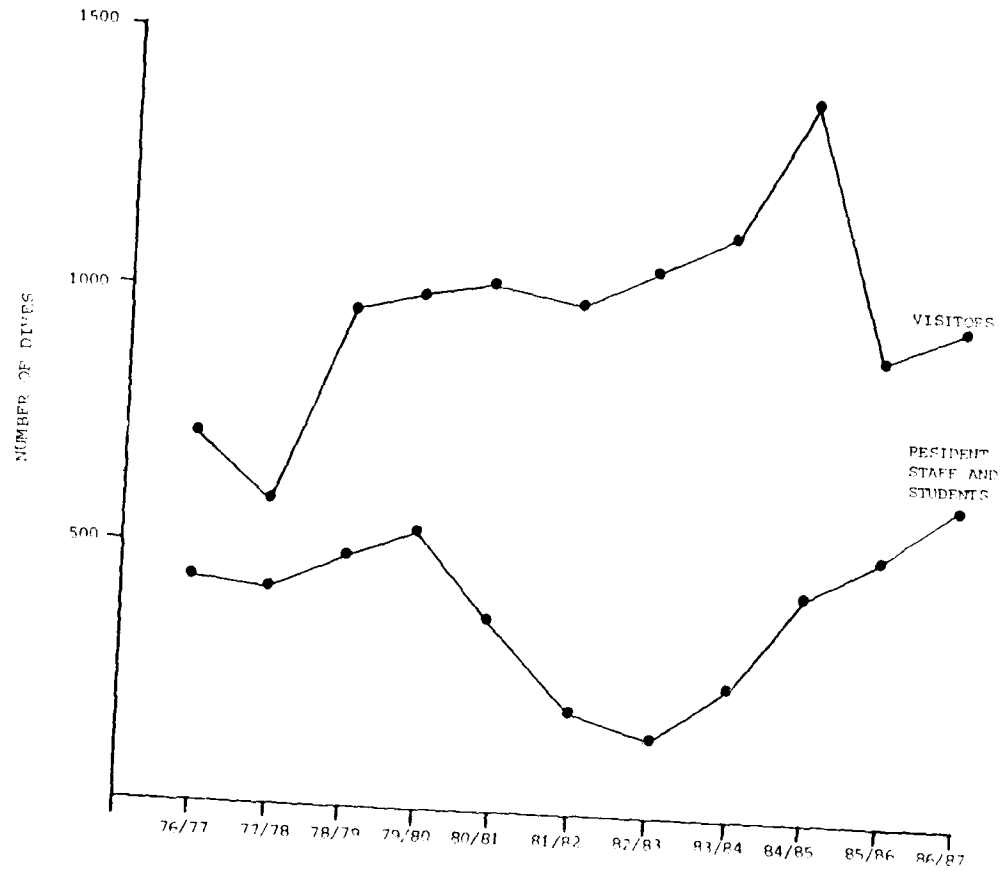
As required by law the high pressure charging system for the air banks was totally replaced and the opportunity was taken to redesign the system. It previously had grown as items were added or replaced. This redesign has produced a much tidier and more efficient system. One of the Yamaha outboard motors was replaced by another of similar size. All other major equipment items have given good service and been free from major problems.

### Number of Dives per Month 1986/87

	A	S	O	N	D	J	F	M	A	M	J	J	Total
Resident staff and students	54	61	56	28	27	30	57	33	45	43	101	34	569
Visiting workers	107	163	120	96	-	3	40	143	10	39	161	87	969
Number of expeditions	37	40	28	22	18	17	28	30	21	27	79	30	377

NUMBER OF DIVES EACH YEAR

1976 - 1987



# Diving Groups

No. of Divers

Glasgow University	Aug 6	1
Glasgow University	Aug 12-13	1
London University	Aug 14	1
Glasgow University	Aug 15	1
Glasgow University	Aug 19	1
Glasgow University	Aug 20-21	2
London University	Aug 21	1
Rochdale BSAC	Aug 23-25	18
SMBA	Aug 28-29	1
Glasgow University	Aug 28	1
Glasgow University	Sept 1	1
Glasgow University	Sept 4	1
Glasgow University	Sept 8-11	2
Glasgow University	Sept 23	1
Glasgow University	Sept 23-26	1
Wearside BSAC	Sept 26-29	19
Norfed Marine Biological Group	Oct. 17-19	20
Marine Conservation Socy. Midlands	Nov. 28-30	16
Glasgow University	Jan. 29	3
Marine Conservation Socy. Scotland	Feb. 27-28	12
Marine Conservation Socy. Scotland	Mar. 1-3	12
Norfed Marine Biology Group	Mar. 6-8	15
Glasgow University	Mar. 26	1
Glasgow University	Apr. 14	1
Glasgow University	Apr. 16	2
London University	Apr. 24	3
SMBA	Apr. 27-28	1
London University	May 1-15	3
Glasgow University	May 21	1
Hull University	May 22-29	3
Glasgow University	May 25	1
Stirling University	May 30-June 3	1
Chorley SAA	June 5-7	8
Scotfed BSAC	June 5-7	7
Glasgow University	June 16	1
Glasgow University	June 18	1
Glasgow University	June 22-26	3
NERC	June 22-26	1
Newcastle University	June 29-30	2
York University	July 6	1
Glasgow University	July 9-10	1
Reading University	July 11-16	2
Chorley SAA	July 24-26	7
Norfed BSAC	July 31	19

## Research

### Crustacea

Mr. R. Powell has commenced a study of females of various species of amphipod and the various costs imposed upon them in carrying developing embryos in an external brood pouch. Eggs of amphipods impede movements and require constant maternal attention. They double in volume during the period they are carried and represent a ballast that not least may involve females in an increased susceptibility to predation. Mr. Powell has spent time in becoming familiar with the local amphipod fauna, its distribution and abundance. In addition, identification of fresh and preserved specimens have been carried out in order to observe the morphological features of taxonomic importance. A sampling programme has been devised and eight gammaridean amphipods chosen for study on the basis of their abundance, taxonomic diversity and habitat diversity.

The sampling programme began in January and will cover a twelve month period with a sample of each species being collected every two weeks. For each sample the following are obtained:- Male/female ratio; the length of the females as measured from rostrum tip to telson tip; the proportion of females that are ovigerous; the number of eggs carried, their developmental stage, and their length and width; the temperature of the habitat. From this it is possible to determine the breeding cycle of each species; the size at which a female becomes sexually mature; the egg volume; the change in volume of the eggs during development.

In addition every two months the following data are being obtained from separate samples: - length of ovigerous females; number of eggs per female; egg volumes; wet and dry weights of ovigerous females and eggs.

From this it is possible to determine the total weight carried by a female, and how this changes during development of the eggs. Seasonal differences in egg weight and development time can also be obtained. Further experiments will be devised to examine the behaviour of egg-carrying females.

Some interesting discoveries have already been made. Initial observations of the epibenthic species Stegocephaloides christianiensis show that all individuals in the sampled population are females, no males could be found. Nevertheless recently two females have been taken each with a single small well-developed individual in their brood pouch. These latter appear to be slightly larger and more robust than juveniles found in the brood pouches of other ovigerous females, and may prove to be small sexually mature males. Perhaps this species is protandrous, with individuals beginning life as males and changing sex as they increase in size.

Dr. P.G. Moore has continued his collaborative researches with colleagues from our parent Universities. Work with Dr. P.S. Rainbow (Queen Mary College) on the biology of heavy metals in amphipods has gathered pace, one joint publication has appeared and another is presently in press.

Concentrations of Cu, Zn, Fe and Pb have been measured in amphipods from marine, littoral, semi-terrestrial and freshwater habitats in S.W. Scotland, including amphipods expected to have high body metal loads. Metal concentrations (y) were affected greatly by body size (x) and could be

modelled by the power function ( $y = ax^b$ ), with the smallest amphipods containing the highest concentrations. This finding cautions against the uncritical use of mean metal concentrations in assessments of heavy metal contamination using crustacean monitors. The effects of seasonal changes and the presence of gut contents on metal concentrations have also been considered and further work is in progress on the former topic.

Work with Dr. A.C. Taylor (Department of Zoology, University of Glasgow) on the fine structure of the gills of an ecological series of talitrid amphipods spanning the habitat range marine/semi-terrestrial/eu-terrestrial has begun using available British species, supplemented with material kindly made available by Dr. A.M.M. Richardson from Tasmania. An attempt is being made to establish whether there is a differentiation of respiratory/osmoregulatory function between gills at different positions on the body.

Taxonomic work on amphipods has continued. The new species Grandidierella propodentata was described from an Australian solar salt works after Dr. Moore was alerted to the presence of an unknown amphipod there by Professor Steve Davis during a visit to Millport (and who kindly organized its collection). The revision of the Tasmanian phytal families Anamixidae, Leucothoidae and Sebidae mentioned last year is now in press and revealed three amphipods new to science: Leucothoe ctenochasma, L. neptunea and Seba chiltoni. The hyperadult male of 'Leucothoides' varrega Barnard was recognized as Anamixis varrega (Barnard). Range extensions were established for Leucothoe boolpooli, L. commensalis, and 'Leucothoides' varrega. Leucothoella gracilis was also collected. The morphology of female and small male Leucothoe boolpooli was established. The Anamixis record proved to be the first for the genus outside tropical waters.

Further taxonomic work on a collection of kelp holdfast amphipods from Tasmania collected by Dr. Moore's Australian collaborator (Dr. G.J. Edgar, CSIRO) will result in three contributions in J. Nat. Hist.

A new Australian collection has been donated by Dr. R.G. Hughes (Queen Mary College) derived from Bass Strait offshore waters which preliminary assessment reveals contains material from an undescribed genus. A small collection of amphipods from Hong Kong donated by Dr. P.S. Rainbow has been analysed and written up for publication.

Requests for assistance with identification of collections from colleagues both at home and abroad continue to mushroom beyond the time available. It is an instance of an essential professional service freely and willingly given to the scientific community on a quid pro quo basis much in demand yet persistently discounted in assessments of scientific effort that does not attract support funds.

Ecological work on phytal communities was summarized in two review papers, one included in the Symposium on the Environment of the Estuary and Firth of Clyde, organized by the Royal Society of Edinburgh, presented new work on the biology of Hyalé nilssoni of a population associated with Pelvetia including seasonal changes in growth rate, sex ratio and breeding status. Fecundity data and data on brood and egg sizes were compared with published data for the same species from different latitudes. The dynamic equilibrium existing between the grazer (Hyalé) and the grazed (Pelvetia) is highlighted.

A more general and joint review with Dr. G.J. Edgar was presented at the International Symposium of seaweed utilization held in Santiago, Chile, in 1985. This considered the role of phytal motile macrofauna for the first time, and with Hick's and Seed's contributions on phytal meiofauna and sessile macrofauna respectively in Moore & Seed's **Ecology of Rocky Coasts**, completes an overall account of macroalgae in relation to associated faunas.

Finally, a joint publication with Dr. D.J. Agnew, described the feeding ecology of two 'under-stone' gammarids, Echinogammarus pirloti and E. obtusatus.

Dr. R.J.A. Atkinson has acted as joint Supervisor for four postgraduate students working on various aspects of the biology of decapod crustaceans and has continued his own researches on burrowing crustaceans and fish. This latter work has included a major review paper, in collaboration with Dr. A.C. Taylor (University of Glasgow), on the physiological ecology of burrowing decapods, and which was presented at a Symposium on decapod Crustacea organized by the Zoological Society of London.

Dr. Atkinson has also participated in a research programme with Dr. A.A. Eshky (past research student, now Chairman of Biology at the Faculty of Marine Science, King Abdul-Aziz University, Jeddah, Saudi Arabia) and Dr. A.C. Taylor (University of Glasgow) on the physiological ecology of crabs from Red Sea mangrove. So far this has mainly involved the direction of aspects of the research programme and interpretation of the early results. The principal species under study is the fiddler crab Uca inversa inversa which occupies a high-temperature, high-salinity environment. A visit to Saudi Arabia is planned and is funded by a research grant to Dr. Eshky.

Dr. Atkinson is also involved with a research programme on nocturnal behaviour patterns of ghost crabs Ocypode ceratophthalmus and O. cordimana. The initial and on-going fieldwork has been carried out by Mr. T. Harland, an undergraduate of the University of Newcastle-Upon-Tyne, who is spending the summer of 1987 in eastern Australia. This, an example of the Station's part in inter-University co-operation was arranged following discussions with Dr. S.M. Evans a long established user of the Station leading courses in animal behaviour.

During the past year Mrs. K. Zainal has continued to study the biology of the squat lobster, Munida rugosa. The primary aim of the project is to examine the physiology and behaviour of this species but some work has been carried out on growth but restricted mainly to a study of allometry. In addition, some observations have been made on reproduction and information has been gathered on fecundity and egg size.

The major part of the study has been concerned with the respiratory physiology of Munida. Partly work has involved a study of the morphology of the branchial chambers and of the gills and the detailed histology of the gills has been studied using both scanning and electron microscopy. Gill ventilation by the scaphognathite has been studied using an impedance technique and comparisons made with other decapods. The rate of oxygen consumption and the heart and scaphognathite beat were examined under different environmental conditions on both active and inactive animals. The effects of environmental hypoxia on these parameters also has been studied.

Records of oxygen consumption rate show that Munida is able to maintain consumption independent of the ambient oxygen tension down to a 'critical' level of between 40-60 Torr. Below this the rate of oxygen consumption declines markedly. This critical level is higher than in some other decapods and indicates that the species is not well adapted to withstand exposure to hypoxia. Much attention has been given to the oxygen and carbon dioxide transporting properties of the blood. Total oxygen carrying capacity and in vivo oxygen tension and pH of the blood of animals under resting conditions has been recorded. Oxygen dissociation curves have been constructed and a study has been made of the effects of temperature and pH on the oxygen affinity of haemocyanin.

In April 1987 Mr. P. Smith started a postgraduate studentship jointly supervised by Dr. R.J.A. Atkinson and Drs. F. Huntingford and A.C. Taylor (Glasgow University) on a laboratory study of the aggressive behaviour of the Velvet Swimming Crab, Liocarcinus puber (L.), an increasingly important commercial species. The initial phase of the project involves a laboratory study aimed at describing the agonistic behaviour of this species and investigating the major influences on pairwise aggressive interactions. This work is being carried out in Glasgow. With the baseline of information subsequent studies will involve investigation of aggressive behaviour in the crabs' natural environment, the effect of aggressive behaviour on the efficiency of capture techniques and multi-individual interactions among communally held crabs. This work will be carried out at Millport. An investigation of short-term activity rhythms will also be carried out at Millport. The respiratory behaviour of Liocarcinus will be followed during and following aggressive interactions to determine the degree of stress that crabs undergo and the nature and length of the recovery period. The work will provide an insight into the physiological cost of aggression.

Studies by Mr. S. Anderson on the physiology of Calocaris macandreae have followed three main themes: (1) an investigation of the burrowing behaviour, ventilation and scaphognathite activity under respiratory stress; (2) a study of gas transporting properties of the blood; and (3) a study of anaerobic metabolism in Calocaris.

In addition to numerous field collections made from R.V. 'Aplysia', Mr. Anderson has spent time at the Dunstaffnage laboratory working with Mr. C. Smith on the latter's study sites in Lynn of Lorne and in Loch Sween with Dr. R.J.A. Atkinson. More recently Axius stirvynchus has been collected from off Devon for comparison with Calocaris.

Dr. R.S.M. Smith completed his studies on the Nephrops within the Firth of Clyde. Because Nephrops incubate their eggs externally they suffer progressive egg loss. Creels were set to capture ovigerous females incubating eggs at various stages of development to provide fecundity data and samples for a study of the biochemical changes associated with embryonic development. During the incubation period mean egg loss is estimated at 18% however, almost a fifth of them suffer additional egg loss, probably at the moment of spawning. Taking such losses into account estimation of the mean number of eggs hatched per female per year ranges from 985-1115. These figures include an allowance for the proportion of the population that may be biennial spawners.



Lipids are the principal energy reserve utilized during embryonic development and full development requires about 6-7 joules per egg. Most energy is expended during the later stages of development and is associated with a rapid uptake of water and salts.

Newly hatched larvae were reared under different culture conditions. Survival was found to be better in isolation as compared with mass rearing conditions and periods of starvation in excess of 1-2 days led to an increase in mortality. Larvae were reared over a temperature range of 8-20°C and relationships have been derived between temperature and the rate of larval development for each zoeal stage. The overall 'optimum' temperature for development was found to be 16°C.

A survey was made in the lower Firth of Clyde to investigate temporal and spatial changes in larval abundance. The data in conjunction with the temperature information obtained in the laboratory study was used to obtain a seasonal production estimate for the first zoeal stage of  $177 \times 10^8$  larvae within the 876 square kilometres sampling area. This value, gives an estimate of  $15.87 \times 10^6$  to  $17.97 \times 10^6$  females in the spawning stock.

Information on the vertical distribution of Nephrops zoeae was obtained over the 24h cycles coinciding with spring and neap tides respectively. The distribution of the larvae was related to environmental variables and compared with the light and pressure responses recorded under controlled laboratory conditions. First, second and early third stage zoea exhibit positive phototaxis and high barokinesis. No dramatic diel changes were detected in the vertical distribution of the larvae. Most remain between 6 to 38 m depth during daylight hours. A limited nocturnal ascent results in the peak abundance shifting from 16 to 5 m depth. Shortly after dawn the larvae descend to their daytime distribution. Depth regulation is probably achieved by light and pressure sensitivity and may be influenced by the position of the pycnocline.

During the third stage the light response changes from positive to negative and Nephrops may first come into contact with the sea bed towards the end of this stage. Substratum selection and settlement behaviour experiments suggest that the first postlarval stage is transitional between the planktonic and benthic environments and final recruitment to the benthos may be delayed until some time after the first postlarval stage. Morphological examination shows that although most structural changes occur at metamorphosis, the development of some adult features are only completed several moults later. Juveniles beyond the first postlarval stages are capable of constructing their own burrows but will enter inhabited adult burrows through surface openings. If the inhabitant does not evict the recruiting juvenile, this excavates an adjoining burrow through one of the walls of the adult's burrow to form a juvenile/adult association.

### **Benthic Ecology**

Dr. Atkinson led a SCUBA survey and assessment of the burrowing fauna of upper Loch Sween in Argyll, which was carried out for the Nature Conservancy Council. The work concentrated on megafaunal burrowers but additionally provided data on the benthic macrofauna in general and the sediments.

The regions of Loch Sween under investigation were Caol Scotnish, Loch a' Bhealaich, Sailean Mhor and Achnamara Arm. Each is distinctive in terms of the density and diversity of its megafaunal burrowers. Interestingly, the poorly oxygenated muds of Caol Scotnish contained large, deep burrows (c. 90 cm deep). The occupants were not positively identified at the time but are now known to be the little known thalassinid decapod Jaxea nocturna. Burrow structure differed, however, from the only description of the burrows of this species and a further period of fieldwork is planned to resolve this and other problems. Two oivales, Mysella bidentata and Saxicavella jeffreysi appeared to be living commensally within these burrows and were probably taking advantage of the oxygenated sedimentary environment in the immediate vicinity of the burrow walls. The sediments of most other regions of upper Loch Sween contained burrows whose shafts opened at the tops of large mounds of sediment. These mounds, formed by sediment expelled from the burrows, were usually between 20 cm and 30 cm in height and were sometimes around 50 cm in height. With a mound density of up to six per square metre, the surface topography was remarkable and indicated considerable bioturbation. Resin casts of burrows showed penetration to a depth in excess of 50 cm. Subsequent work showed that the echiurid, Maxmulleria lankesteri was responsible for the largest mounds, but the thalassinids Jaxea nocturna and Callianassa subterranea were responsible for others.

The thalassinid, Callianassa subterranea, which did not always generate mounds around its burrow openings, occurred in several regions of Loch Sween, particularly in part of Achnamara Arm. The deepest burrow cast was 74 cm in depth. This species was most abundant in regions of sandy mud in contrast to the silty-clay muds where the other mound-building species were most abundant. The sediments in deeper water of Sailean Mhor and Achnamara Arm also contained low densities of the thalassinid Calocaris macandreae. All regions of the upper loch except Caol Scotnish contained the Norway lobster, Nephrops norvegicus. Some burrows cast with resin showed adult-juvenile burrow associations. The burrowing Fries' goby, Lesueurigobius friesii also occurred in the same areas as Nephrops. In addition, the black goby, Gobius niger, and the sand goby, Pomatoschistus minutus occupied burrows but these were usually those of Maxmulleria lankesteri, Jaxea nocturna or Callianassa subterranea. The association is in all probability an opportunistic one, however, the observed association between Processa nouveli holthuisi and thalassinid burrowers may be closer.

Upper Loch Sween sediments appear to be high in organic content, but a series of cores suggest that macrofaunal density and diversity is relatively low. This is contrast to megafaunal burrowers which occur at high densities and it is hoped that their interaction with the macrofauna will be the subject of further investigations.

Mr. C.J. Smith has almost completed his studies into megafaunal/macrofaunal burrowing interactions in marine soft sediments. Species abundance at both mega- and macrofaunal levels is determined by external physical factors such as organic enrichment and disturbance due to

fishing pressure, however, detailed diver coring at one site to investigate biological and physical conditions shows that the burrowing crustacean Nephrops norvegicus significantly affected the macrofaunal community structure by modification of the sedimentary environment and increased instability.

Experimental sediment mesocosms have been used to investigate the disturbance process further; in particular the interactions of Calocaris macandreae and N. norvegicus with particular species, groups of species and with the sedimentary environment. Results indicate that the two species have markedly different effects. N. norvegicus is a sediment disturber, causing a decrease in macrofaunal species number, abundance, biomass and activity. Decreases are mainly via indirect means, mediated by burial and increased turbidity but also by the general foraging and burrowing activities of the crustacean. In contrast, C. macandreae, although causing some disturbance, had an overall enhancing effect on community structure probably through the release of nutrient rich sediments to the sediment surface. Species such as Amphiura chiajei, Turritella communis and Corbula gibba were seen to take advantage of this.

To investigate the effects of organic enrichment on the presence of burrowing crustacea, visits were made to the DAFS, Aberdeen to inspect videos taken across Garroch Head sewage dumping ground. In addition R.V. 'Aora' towed a video sled along set transects through the ground. Changes in macrofauna community structure along these transects is also recorded annually by the SMBA and it is intended to integrate these various observations. The centre of the dump is devoid of visible life but has a high population of opportunistic polychaetes, oligochaetes and nematodes. Abundances of burrowing megafauna increase away from the dump centre, but are patchy having been affected by demersal trawling.

Mr. C. Smith has also assisted in other projects, notably with diving work. Projects include: branchiopod population surveys (Glasgow University), the effects of fish farms on the marine environment (Stirling University/NCC), predator/prey exclusions (Heriot-Watt University), sampling gear development (Institute of Offshore Engineering) and lobster ecology (SMBA).

Mr. T. Nickell's studies on the behavioural ecology of epibenthic scavengers in static water conditions was concluded in 1986. In particular Liocarcinus depurator, Asterias rubens, Hyas araneus and Ophiocomina nigra were investigated in the experimental tank. All four species showed behaviour in response to food odour significantly different from random ( $p < 0.05$ ). A list of eight species under investigation was ranked on the basis of increasing  $\chi^2$  value previously determined as a measure of departure from randomness. This ranking of static behaviour was then compared to a field ranking of the same species based on the increasing numerical constituent of the catch on a monthly basis from 1983 to 1984. The two ranks were compared using the Spearman rank correlation test and found to be not significant at the 10% level ( $p > 0.10$ ). This would seem to suggest that animals in the field are more efficient scavengers in the presence of water currents than they are in static conditions.

To test this suggestion a large 2 m long circular current tank was constructed of ABS. The current is provided via a large paddlewheel driven by a 0.5hp electric motor. With a width of 0.50 m and an operational water depth of 0.20 m the tank holds a maximum volume of 373 l. An 1 m long

straight experimental portion of the tank was marked in 1 cm divisions. Animals were placed in the centre of this channel (position zero) and positions of the animals were noted at 30 second intervals. The time taken for an animal to reach either the upstream or downstream endpoint was also noted. Trials were run at two current velocities, 0.1 and 0.3 m sec<sup>-1</sup>, and under unbaited and baited conditions. The bait used was a known weight of cod fillet. Experiments were run for five minutes. The position of each animal is plotted as a graph of distance vs. time, and the area under the curve is plotted on a digitizer. From this the average velocity over a five minute interval can be estimated. Comparisons were then made between the various conditions i.e. low and high velocity, baited and unbaited, using the Z test for unmatched pairs. Thus a ranking of scavenging behaviour at low and high velocities is being built up for comparison with the static and field ranks.

Investigations in the field have continued along with the laboratory work. A baited underwater video camera in conjunction with a self recording current meter has been used over two 24 hour cycles to coincide with spring and neap tides.

Professor J.A. Allen has carried out a benthic survey to study the effect of salmon and trout farming in Loch Riddon. The work funded by Rothesay Sea Foods Ltd. shows that perturbation following the increased oxygen demand caused by excess fish meal and faeces falling to the sea bed is limited to the area immediately below the fish pounds and a little beyond. The study also showed that the sublittoral fauna of Loch Riddon is particularly diverse and varied with many unusual species present and possibly merits consideration for the extension of the protection given by the existing intertidal site of Special Scientific importance at the head of the Loch to the subtidal areas.

#### **Mollusca**

Dr. P.M. Rhind and Professor J.A. Allen have continued their studies on the deep sea protobranch molluscs of the Atlantic. A major account of the Family Nuculidae is now in draft. In particular it is concerned with quantification of the subtle differences that occur in the morphology of intraspecific populations of the various basins. The antiquity of the deep sea nuculids has been confirmed in contrast to the shallow water species. The vast majority of the deep sea species have non-crenulate shells. Non-crenulate species are found in the Ordovician whereas the crenulate species (which dominate in the shallow seas) did not appear until the Cretaceous. Indeed there is a marked discontinuity between shallow and deep water species on the upper continental slope. Although largely preadapted to a deep sea existence, deep sea species do exhibit morphological adaptations of size and development related to nutritional impoverishment.

Professor J.A. Allen has continued to work on further draft accounts of the molluscan deep sea bivalves.

Mr. D. Chevis and Professor J.A. Allen completed their studies on techniques of open-sea culture of mussels and presented their report to the Highland & Island Development Board.

Professor J.A. Allen has also been concerned with the identification of sub Antarctic bivalves from Kerguelen Island and contributing in small part to chromosomal studies of these molluscs by Dr. Catherine Thiriot-Quievreux of

the Station Zoologique, Villefranche-sur-Mer, France. This work is now being extended in a joint study analysing the chromosomal relationships of the British species of nuculid bivalves.

#### **Fish**

Mr. A. Downie, Junior Dulverton Fellow, has commenced a study on the effects of sludge dumping on the reproduction and growth of commercial flatfish (Plaice - *Pleuronectes platessa* (L.)), under the supervision of Professor J.A. Allen and Professor R.J.H. Beverton, (UWIST, Cardiff).

Initial work has involved familiarisation with the animal and the relevant literature published about it as well as reviewing the literature on marine pollution relevant to sludge dumping. Practical work in the first few months of the project were taken up, trials of sites and gear with new pieces of equipment being obtained and constructed as necessary. Advice was sought from Dr. Poxton (Heriot-Watt), Dr. Pearson (SMBA, Oban), Dr. Gibson (SMBA, Oban) and Professor Beverton on the design and working of the basic sampling programme.

The sampling is simple in concept in that 'polluted' and 'clean' nursery areas for juvenile flatfish will be compared and the growth of the fish investigated. Two sites Kames Bay (Millport) and Southannan Sands (Fairlie) were chosen as polluted areas closest to the sludge dumping site whilst Ettrick Bay (Bute) was chosen as the clean control site. Adult populations of flatfish in the adjoining deeper waters are being sampled to try and establish parentage and to test for pollutant levels as are the populations at the perimeter of the dump site.

The fish tissues will be analysed for heavy metals through the kind assistance of DAFS Aberdeen who also has a particular interest in the Clyde site. Sampling began in April and will continue on through to November. Currently Kames Bay is being sampled approximately once per fortnight, Southannan once every three weeks and Ettrick Bay once per month. The adults in the three areas are sampled once every three months and analysis of gut contents is being carried out.

Initial trawling and survey work in the nursery areas was carried out using an Agassiz Trawl, however, it was decided to switch to a 2 m beam trawl to standardize with work done elsewhere on juvenile plaice by other workers. The system of survey is one of parallel tows increasing depths to determine the greatest depth at which young plaice occur. The trawl is then placed on the beach at the edge of the water and towed off to the depth at which no fish has been found in the parallel tows, thus sampling the whole population. Tows are made from different parts of the beach.

#### **Microbiology**

The work of Dr. Valerie J. Smith has focused on completing a survey of phenoloxidase activity in the blood of different marine invertebrates and on a more detailed kinetic study of phenoloxidase, prophenoloxidase and protease activities in tunicate coelomic fluid (*C. intestinalis* and *A. mentula*). The tunicate proPO system was found to closely resemble the arthropod system, at least in terms of enzyme activation, activities, and sequence of activation. Functional studies of this system are planned for 1988. With crabs, the blood cell lysates were cross reacted against antibodies raised towards a cell adhesive protein and degranulating factor purified from crayfish (in Sweden)

for antigenic similarity. None was found! Similarly Ciona haemocyte lysates failed to cross react with affinity purified PO antibodies from crayfish. Functional studies of the various molecules are planned for 1988. The invertebrates tested for phenoloxidase activity included the brachiopod, Liothyrella uva and two species of isopods from the Antarctic (Glyptonotus antarcticus and Serolis sp.). The latter both lack PO activity but possess strong protease activity towards the synthetic chromogenic peptide S2337. So far these are the only two known arthropods to lack PO activity apart from Limulus polyphemus. Further research on these Antarctic animals is planned in conjunction with the staff of the British Antarctic Survey in Cambridge.

Research was also carried out on the bactericidal activity of crab, C. maenas, haemocytes in vitro with Mr. K.D. Bruce, a final year Microbiology student from Glasgow University. It was found that in Planococcus citreus and other test bacteria, killing occurred within 20 minutes but there was no significant difference in killing time between different bacterial species. Heating and haemocyte lysate supernatants (HLS) to 58°C for 10 minutes to active phenoloxidase, non-physiologically, reduced bactericidal activity, but killing was still observed after freezing to -20°C for 48 h. The HLS caused partial lysis of Escherichia coli Lilley and clumping of P. citreus. The mechanism of killing, the nature of the killing factor and its relationship to the proPO cascade remains unknown.

Other work on the bactericidal effect of antifouling paints or their components was also carried out by Dr. Smith and Miss Ailsa Clark, a final year Biology student at Napier College, Edinburgh. Using a pour plate method with filter paper discs impregnated with the appropriate paint or paint component, it was found that a range of Gram negative, Gram positive, marine and non-marine bacteria are susceptible to killing by copper, organotin or rosin-resin based paints in vitro. Gram negative, bacteria, however, were observed to regrow in the presence of the paint and isolation of these colonies revealed that they had developed 'resistance' to the paint toxin. More detailed studies were undertaken using tributyltin (TBT) based Cruiser Co-Polymer paint (International Paints Ltd). By repeated serial subculture of various Gram negative isolates in increasing paint concentrations, bacterial substrains capable of tolerating 0.15% paint in the culture media, were obtained. Related field studies showed that TBT-resistant bacteria occur naturally in the sea, especially in yacht marinas and harbours polluted with organotins. Attachment of bacteria to microscope slides treated with Cruiser Co-Polymer were more rapidly colonized in these areas than similarly treated slides in relatively clean waters. Priming the slides with laboratory-raised resistant bacteria further enhanced microfouling but as yet the importance of bacterial resistance to antifouling paints in slime formation on submerged surfaces in the sea is unknown. Further studies on the ecological effect of TBT-resistance in marine micro-organisms is planned for 1988.

Dr. Joy Sturtevant has continued her research on haemocyte co-operation in the internal defence mechanisms of crustaceans with Dr. V.J. Smith. Most of the work was carried out at the laboratory of Dr. K. Söderhäll, Institute of Physiological Botany at the University of Uppsala, Sweden. This included the continuation of the isolation and characterization of serine proteases which are important constituents of the prophenoloxidase activating system in arthropods and assumedly important in immune defence. Methods used were heparin sepharose and antibody affinity chromatography. Because of the

lability of the enzymes as well as the low amounts available in crayfish, isolation was difficult. Therefore, much of the time was spent on trying alternative methods to isolate the serine protease. These included other types of affinity chromatography and isoelectro-focusing. The latter appears to be the best approach and will be used in conjunction with gel filtration, however, large amounts of the protease will have to be accumulated which means 100's of crayfish being bled. An additional project was the isolation and characterization of a factor in the plasma which enhances prophenoloxidase and serine protease activation. Dialyzed plasma is run over laminaran epoxy sepharose columns. Material eluted with high salt has the enhancement activity. Native gel electrophoresis has resulted in one major band at 120kD which migrates in the second dimension to 68kD in a non-reducing sodium dodecyl sulphate polyacrylamide gel. Other fainter moieties in the native gel migrate to 160kD and 78kD spots. When the eluted protein is run in a non-reducing SDS polyacrylamide gel in the first dimension, 3 protein moieties result: 160kD; a 68kD/72kD doublet; and a fainter doublet at 78kD/80kD. When a non-reduced strip is run in reducing gel in the second dimension, the 160kD band migrates to 68kD and the doublets migrate the same. Studies on the properties of the purified protein and how it interacts with the haemocytes are now under way in Millport. Additionally, biochemical research is being introduced including gel electrophoresis, immunoblotting, and affinity chromatography. These techniques will be used in Millport to work on isolating and studying opsonization and phagocytosis in the shore crab, Carcinus maenas.

#### Contract Research

Considerable efforts continue to go into the seeking and negotiation of contract research funds of various kinds. The scale of the effort is dictated partly by the small permanent science base at the Station, four academics including the Director, and partly by the unavoidably limited spread of their expertise. Nevertheless, this year has seen contracts successfully negotiated with Rothsay Sea Foods on the impact of a marine fish farm on the adjacent benthic fauna (Professor J.A. Allen), with the Nature Conservancy Council on the assessment of the benthic fauna of Loch Sween at Proposed Marine Nature Reserve (Dr. R.J.A. Atkinson), and on structures at Morecambe Bay (Dr. P.G. Moore). Other benthic surveys are in the process of being negotiated with potential industrial clients.

Our extremely close co-operation with DAFS continues, indeed, mutual research interests are presently being strengthened and it is a matter of great encouragement to the Station that this should be so. R.V. 'Aora' in particular, has been active in carrying out a large amount of survey work for the Department, particularly in matters of mutual scientific interest. We would wish to thank the Director and staff for their confidence in the Station's ability to provide a competitive facility of a high standard.

Following a number of tentative enquiries we are giving serious consideration to costing a service testing the toxicity of various effluents and substances. We believe that we can mount a pilot scheme to test our ability to provide a service of this kind and if successful it may be possible to expand to an extent where we could employ additional staff to work on the effect of a variety of toxic substances in marine organisms.

Much of this year has been spent formulating and submitting research

proposals for grants and fund-raising for sponsored research and concerned with the need to foster research links with other scientists, often in other disciplines both at home and abroad. For example, Dr. P.G. Moore hosted a visit (July 1987) by Dr. A.M.M. Richardson of University of Tasmania with whom discussions were had on the possibility of collaborative research on talitrid amphipod ecology. Further discussions along different lines are in progress with Professor A.A. Myers (U.C., Cork), Mr. E. Stentiford (Civil Engineering Dept., University of Leeds), and Dr. M.B. Jones (Plymouth Polytechnic), Professor A.D. Hawkins (DAFS, Aberdeen), and Dr. R. Mitchell (NCC) with a view to establishing and improving co-operative links.

#### **Artist-in-Residence**

The Station welcomed its third consecutive Artist-in-Residence, Ms. K. Maclean. As this scheme has progressed succeeding Artists-in-Residence, while based at the Station and with marine interests, have become more involved with the Community at large. In the case of Kay Maclean, this has been taken further in that a proportion of her time is to be spent in Cunninghame District at large and the District Council have been able to support this with a materials grant. Thus, Ms. Maclean reports that it has been possible to divide her time in two areas.

##### **1) Work with the Community:**

"I have, since February, attended Cumbrae Primary School once a week and with the kind help and enthusiasm of Mrs. M. Kidd and her staff worked on various individual projects with the pupils culminating in a backdrop for the end of term musical 'Oliver'.

I have recently designed the cover for the MB2 manual for Dr. Valerie J. Smith.

Robert Forsythe, Leisure & Recreation Officer, Cunninghame District, suggested and helped to arrange various projects including:-

A successful day-long workshop at the Museum of the Cumbraes, Millport. Despite a wet, windy, March day approximately 150 people visited.

A similar workshop for two days at the North Ayrshire Museum Saltcoats was also very successful and resulted in a finished painting of the Saltcoats Sea Queen.

With the help of Captain Sillars of the Heritage Museum, Brodick, Arran, and the staff and pupils of Arran High School, I spent a week with a group of 3rd year pupils illustrating the folk story of 'An Leannan Crodanach' with first-hand information at the Museum. This project really took off and I hope to return in the near future to finish it off.

I spent three days at the Harbour Festival, Irvine, and hope to develop ideas from this.

I have various other venues to attend over the next four months including some small shows of my work in Irvine and/or Ardrossan and a show to be



arranged at the end of the year in the Museum of the Cumbraes".

## 2) Personal Work

"I feel without the stimulus and challenge of working with others, especially young people, my own work would be meaningless. The two areas overlap and feed off each other even though my own work is very personal, sometimes to the point of monotony, in self-representation. The series of drawings and painting executed over the past seven months are a narrative of my feelings and visual observations, often 'tongue in cheek' of my life, living at the Station and in Millport. Each piece is a spin off of the one before - a continuing story in paint. I have used shells from the shore and made fish out of clay to make mock gold frames to frame my paintings, not just as frames but as an integral part of the painting. I have incorporated shells and fish on some canvasses to make 3-dimensional paintings with flat areas of paint rather than creating the illusion of '3-D' on a piece of canvas. The staff of the Station have been invaluable with help from framing to photography and have a quiet inquisitiveness about the work I am doing. I am interested myself to see how my work will evolve over the next four months as I believe that the preconception of a finished painting is impossible and the success of a painting is in realising the potential of the mistakes!"

The Station greatly benefits from the presence of the Artist-in-Residence - it has proved a novel development, and has led to an enhancement of the Station not only in possessing a variety of works of art by young and talented people, but more importantly as the focus for all staff and students, particularly the younger members who provide a refreshing non-scientific insight and approach to the work of the Station.

## Visitors and their Research

As usual, in order to provide some insight into the range of research which is carried out at the Station a small selection of that which has been carried out by visitors is reported upon here.

Dr. B.W. Mullins of the British Antarctic Survey carried out trials to establish the optimum incubation time and optimum substrate concentration for the uptake of  $^{14}\text{C}$ -organics and  $^3\text{H}$ -thymidine by marine bacteria in low in situ temperatures ( $4^{\circ}\text{C}$ ).

Miss E. McDonnell and Mr. A. Ramsay of Glasgow University have made frequent visits during the year to the study of microfouling organisms causing corrosion of stainless and structural steels used in offshore installations.

Mrs. K. Cocking of Manchester Polytechnic revisited to continue her studies on the Bryophytes of the Cumbraes.

Mr. M. Simmonds of Queen Mary College has continued his studies on the effectiveness of Vanadium-based additives to antifouling paints.

Mention must be made of Miss Ailsa Clark, a final year undergraduate of Napier College, who carried out a 4th year honours degree research project under the supervision of Dr. V.J. Smith. An exceptionally fine piece of research was carried out on the bactericidal efficiency of various antifouling

paints including those containing TBT. Miss Clark was able to investigate bacterial regrowth following inhibition and confirmed resistant strains of Gram-negative bacteria growing in significant concentrations of TBT paint. In situ studies indicate that such bacterial resistance could play a major part in the promotion and development of the fouling process.

#### **Robertson Museum & Aquarium**

Following the ending of the teachers' dispute the numbers of school visitors to the Museum are back to the level of earlier years. The total number of visitors was 6818 of which 1377 belonged to school groups. For some time we have been giving thought to the refurbishment of the Robertson Museum and its exhibits. It has been clear for a number of years that this task has been becoming more and more urgent. Thus, Dr. P.G. Moore and Mr. D.J. Murden have initiated a series of activities as the first steps in this process. Over the past year we have had regular visits from Miss Ruth Charity and Mr. Mark Murray, both EEC funded students studying at the Collins Gallery of Strathclyde University, for a postgraduate qualification in Museum design and Exhibition Management. As part of their training they undertook a feasibility study investigating the potential development of the Robertson Museum & Aquarium. Their report has now been printed and has been very well received. It gives an authoritative basis on which to plan and cost improvements.

Miss Charity and Mr. Murray have presented three options for refurbishment and redevelopment. These range from a modest refurbishment costing approximately £7,000 through a medium redevelopment at £28,000 to an uncostered development including a new building. We believe in view of present financial circumstances that the second option is the one which should be pursued and we have already taken steps to solicit support from both public and private sources.

As part of this redevelopment we intend to produce booklets and teaching aids for visiting school parties and to extend the range of elementary and intermediate text books for sale in the museum. We will also extend the range of souvenirs sold.

Ultimately we should hope to raise sufficient funds to employ a part-time curator who could fulfil the dual role of curator and extra curricular teacher. We feel that the Station should play a part in education both at primary and secondary level and adult and continuing education as well as its present role for undergraduate teaching.

In addition Mr. B. Ramer, Project Co-ordinator, Scottish Museums Council, Mr. J. Hancock and Mr. F. Woodward of the Kelvingrove Museum, visited and assessed the state of conservation of our collections. Their recommendation was that greater funding be made available to enable the more appropriate storage of important material from the Robertson collection currently housed in inadequate conditions.

All in all, this is likely to develop into a major reorganization and fund raising exercise over the next few years, encompassing the elements of a worthwhile and exciting development which, properly handled, could be both educative and self-financing.

## **Service & Facilities**

### **Buildings**

It is a great pleasure to report that through the generosity of the Trustees of the Wolfson Foundation the Station now possesses a splendid Lecture Hall. Work on the foundations began in November 1986 and the building was ready for occupation by March 1987. It is of a simple design, a clad and rendered Terrapin construction and extremely well fitted out with up to date audio visual aids. The building is designed to seat 80 students in seats with an integral writing platform, however, the latter are removable and by so doing it is possible to seat at least 100 persons for a conference event. Mrs. Kathy Beverton, wife of Chairman of the Committee of Management, very kindly consented to open the building at a small ceremony on the 30th April, to which Committee of Management Members, contributors to the Centenary Appeal, and Station staff were invited.

The building has shown that it more than meets our expectations of it and has proved a considerable asset. We have already had demands to hold seminars and conferences additional to our normal visiting course customers.

Elsewhere the upkeep of the Station buildings was governed by the very reduced allotment to maintenance funds. In effect this meant that work was restricted to some painting and replacement of rotten window frames and necessary electrical and plumbing repairs. Winter storms badly affected the main sea water intake pipeline and forced the renewal of the pipe and its protective cover as well as the fabrication of a new protective cage around the intake. This work has been carried out by Station staff and in particular by the Station Engineer Mr. R. Young and Caretaker Mr. G. Campbell. Similarly it is due to the excellent servicing by Mr. Young and Mr. Campbell that the pumps have run more smoothly than can be remembered. Staff are to be congratulated on their care and upkeep of the Station properties.

There has been some movement towards the solving of the very major problems that exist of long-term maintenance. Thus, an order has been placed to replace the rotten porchway to the main entrance to the Museum & Public Aquarium. Refurbishment of the obsolete and potentially dangerous sections of the main electrical system of the main Station have been costed and tenders requested. The re-roofing of the oldest part of the building, necessary to save the valuable library stocks which are flooded at every major rain storm, has been costed. It remains to be seen whether the funds for these absolutely essential works will be forthcoming.

Despite these major problems the Station has offered first-class facilities and service to a very large number of people who have passed through during the year. Not including the general public, some 1,300 persons visit the Station for 8-9 days on average during the course of a year. This constant flow requires efficient handling and good care, and it is ever a pleasure to report that this occurs unfailingly. It is due to the fine efforts of the Chief Technician Mr. A. Elliott, and the Domestic Bursar Mrs. M. Allen and their staff, that the operation runs so smoothly. This is a view that is repeatedly confirmed by numerous letters of commendation from course leaders and visitors.

### Equipment

Mention has already been made of the renewal of ship survey equipment and diving equipment also the audio visual equipment including video recorders associated with the new Lecture Hall. In addition a sophisticated Valeport Current & Temperature recording instrument was purchased. This was put into immediate use in Loch Riddon to monitor water flow in the vicinity of the fish farm and to support the work of Mr. T. Nickell on chemo-sensory behaviour of epibenthic scavengers off the Little Cumbrae. An additional BBC Master computer and a replacement Yamaha 30 outboard motor for the divers' inflatable dinghy has been purchased. Our greatest requirement remains additional experimental Constant Temperature Rooms and some equipment funds have been set aside to meet this need. Lack of available space remains a formidable obstacle to solving this. At present, negotiations are in progress to set up an outside unit and to refurbish an existing facility. In the meantime one of our small old butcher's coldrooms has had a new cooling unit fitted to enable Dr. V.J. Smith to carry out experiments on living Antarctic crustacean species. Dr. Smith has also been able to purchase a range of electrophoresis equipment in part via her SERC grant and in part with the aid of Station equipment funds.

### Research Vessels

As in recent years, there has been a continued and intense demand for research vessel time and all users have had to accept curtailed work programmes in order to provide sea time for all who require it. This year the problem was made worse by a major engine breakdown in R.V. 'Aora' and crew illness.

R.V. 'Aora' underwent a major scheduled engine maintenance programme in early February and the vessel was berthed in King George V dock, Glasgow. There the engine manufacturers, Kelvin Diesels Ltd., made an extensive top-end overhaul of both RA6 engines and which included valve, cylinder liner and piston ring replacement, and renewal of gearbox clutches of the starboard engine. Visual inspection of the 'big end' journals suggested that there were no problems with the crankshafts. Unfortunately, two weeks later, R.V. 'Aora' suffered a major starboard engine breakdown involving the failure of the main bearing journals with consequent damage to the crankshaft which required re-grinding. The repair was carried out by Kelvin Diesels Ltd. at Largs Yacht Haven, the nearest all-weather berth to Millport. The regrinding of the crankshaft was carried out by Andrew Master Hones Ltd. of Paisley.

Fortunately in view of the earlier maintenance, the cost of the repair was borne by the Insurers. Unfortunately, the vessel was unavailable for 16 working days which caused substantial disruption of research programmes.

R.V. 'Aplysia' also suffered engine problems caused by overheating. This was resolved by re-routing the cooling water, re-grinding the cylinder head and renewing the water pump and heat exchanger. This accounted for 13 of the 14 days lost through breakdown.

The crewing of the vessels, which is subject to Department of Transport regulations, allows for certain combinations of crew transfer between vessels.

Ship Operation Analysis: 1 August 1986 - 31 July 1987

	AORA		APLYSIA	
	1986/87	1985/86	1986/87	1985/86
Statutory holidays and lay-ups (days)	28	29	27	33
Potential working days (excl. overtime)	233	232	234	228
Actual days worked (as scheduled)	207 +5 **	218 +9 **	186	181
Loss due to crew transfer (days)	3	6	29	25
Loss due to bad weather (days)	2	5	4	12
Loss due to breakdowns (days) ***	20	1	14	10
Loss due to fouled gear (days)	1	2	1	0
Scheduled maintenance (days)† **	43 (20%)	58 (26%)	21 (11%)	19 (10%)
Sailing days **	169	169	165	162
Teaching	36 (21%)	35 (21%)	10 (6%)	14 (9%)
Research	81 (80%)	78 (74%)	33 (89%)	34 (90%)
Specimen Supply	52 (31%)	56 (33%)	122 (74%)	114 (70%)
	100% 100%	100% 100%	100% 100%	100% 100%
Number of 24h trips	2	0	0	0
Number of trips of 2 days and over *	9	5	0	0

\* Work in conjunction with the Department of Agriculture and Fisheries for Scotland.

\*\* Overtime days (weekends, statutory holidays). Scheduled maintenance days and sailing days include such overtime days. Extended hours on normal working days are excluded from analysis.

† Includes gear and mooring maintenance and for 'Aora' crew 4 days dinghy maintenance, usually combined with other maintenance work.

On-board tuition of PhD students is included under Research but all taught course postgraduate vessel time is included under Teaching.

\*\*\* Additionally, 4 overtime days (weekends) necessitated by breakdown were worked.

There are particular problems when 'ticketed' crew members are absent for any reason. Unfortunately there were occasions when qualified men were absent through illness, and made it impossible to operate both vessels together. As a result R.V. 'Aora' was given priority to meet important research and charter requirements and inshore studies were consequently disrupted. The practice of laying-up each vessel, so that crew take their holidays synchronously, normally means that remaining leave can be so adjusted that both boats can continue to work, this year, however, crew illness combined with leave requirements prevented this, and R.V. 'Aplysia' could not sail on 29 occasions.

In contrast on three occasions R.V. 'Aplysia' was given the priority and the R.V. 'Aora' was at moorings.

Fortunately it was not necessary to slip either vessel during the year and paintwork was carried out at the moorings and R.V. 'Aplysia' was antifouled in Millport Harbour. The antifouling on R.V. 'Aora' remained effective and was not renewed.

A programme of upgrading the bridge equipment of R.V. 'Aora' was commenced in 1985. This year the Racal-Decca Mk 21 navigator and MAP350T electro-mechanical plotter were replaced with the computerized Mk 53 version with a CVP3500 colour video plotter. This has meant a significant improvement in fishing ability and safety which has enabled us to exchange research trawling information with the Department of Agriculture & Fisheries for Scotland much more easily than hitherto. The Racal-Decca 101 radar system was replaced with an ex-demonstration Racal-Decca 270 'bright track' system when it became clear that further repairs to the obsolete 101 system were uneconomic.

The proportional use of vessel time was similar to the previous year. The greatest proportion of the time allocated to R.V. 'Aora' was devoted to research work, including chartered research. In the case of R.V. 'Aplysia', most time was devoted to the collection of marine specimens for sale to academic institutes. There was a slight reduction in the amount of time used on R.V. 'Aplysia' for teaching purposes and a slight increase in the time used in connection with the specimen supply trade which reflected an increase in the demand for creel collected scampi (*Nephrops norvegicus*).

As expected, the smaller vessel, R.V. 'Aplysia' was more vulnerable to bad weather than R.V. 'Aora' and lost twelve days sea time in contrast to the four days lost by R.V. 'Aora'. The time lost due to fouled gear was minimal.

#### Specimen Supply

With the continued Government squeeze on financial support for education leading to the re-adjustment of department expenditure in the universities' and colleges throughout the country as well as a more conservative use of both living and preserved specimens for teaching and research, it is inevitable that this has had an effect on the Sales Department culminating in a slight but significant reduction in orders processed.

As well as regular orders sent to teaching departments of universities

and colleges, once more the Beatson Institute for Cancer Research was supplied with large numbers of Nephrops as was the new Addenbrooks Hospital in Cambridge. As an indication of the type of demand, we supplied the Ministry of Agriculture, Fisheries & Food, Lowestoft, with about 300 Butterfish, the Water Research Centre at Marlow with small Plaice and a collection of the Polychaete worm, Capitella capitata. Heriot-Watt University was supplied with Flounders throughout the year and similarly the Department of Agriculture & Fisheries for Scotland, Aberdeen, were supplied at intervals with codling and shore crabs. D. Cobb and Dr. Hazon of the Gatty Marine Station, St. Andrews, were again supplied with Ophiura and Scylliorhinus for their respective researches.

Foreign orders of note included large specimens of the winkle Littorina littorea sent to Iceland to ensure a Ph.D. student finalised his thesis. Two consignments of the sea urchin, Psammechinus were flown to the Institute of Cell Biology in Zurich and a similar consignment to Dalhousie University in Nova Scotia - Millport remains the only supplier in the world of this particular sea urchin. Scallops were flown to Frankfurt for use at the Max-Planck Institute for Medical Research, Heidelberg, and a large number of Corbula gibba (300+) were flown out to the University of Michigan. Many preserved species were sent once more to India.

Maintenance work by the department staff concentrated on the painting of the exterior walls of the complex.

Again we would like to thank Professor Currie and the staff of SMBA at Dunstaffnage for their assistance in the Autumn and Spring collecting trips. Also thanks are due to the British Rail staff at Largs and Glasgow, and Caledonian MacBrayne staff at Largs Pier, for their continued efficient handling of our goods.

#### Library

The library becomes even more useful and comprehensive under the excellent care and attention of the librarian Mrs. N.C. Cameron. It is now a very significant specialized library of national standing. The bookstock has grown to over 3,000 volumes while serial publications amount to some 800+ titles and over 10,500 volumes. Over 21,000 reprints have now been catalogued and are increasing rapidly due to the continued receipt of substantial gifts (see p. 36) over the past year. The importance of the gifts we receive can be measured by the fact that we receive some 180 current periodicals yet we are only able to purchase 35 of these.

Library finances have been even more restricted. We were able to purchase no more than 58 books - an all time low - and relied heavily on our participation in the British Library Gift & Exchange Scheme to augment our holdings. Mainly from this source, we were able to add a further 106 books, mostly important out of print works. We were unable to commit any funds to binding.

#### Staff Appointments, Resignations & Retirements

Very few changes occurred in staff complement during the year.

Dr. P.G. Moore was promoted to a Senior Lectureship w.e.f. 1st August, 1986.

Mr. H.E. McDermid, Handyman, retired as from 31st July, 1987, after eleven years service.

Ms. K. Maclean was appointed Artist-in-Residence as from 21st January, 1987.

The posts of Mr. P.J. Lonsdale, Chief Diving Technician and Mr. G.F. Gale, Microbiology/Computer Technician were regraded to UTS 6 and UTS 4 respectively.

#### Events

The Committee of Management met on two occasions; at Senate House on 7th November, 1986, and at Millport on 30th April, 1987.

The Committee welcomed Mr. Jack Hind and Professor P.J. Peterson as new Members of Committee.

We were delighted to welcome Lord Goff of Chieveley, Chairman of Court of University of London and Lady Goff on the 13th March, 1987. We were also delighted to welcome Lord Flowers, Vice Chancellor and Professor A.O. Betts, Deputy Vice-Chancellor on 19th March and 29th May, 1987, respectively, and to show our visitors at first hand something of the varied work of the Station. As a result of these visits most useful discussions were held on the role of the Station and its ability to respond to perceived future demands.

Other visitors included Board members and officials of the Highland & Islands Development Board on 25th May, 1987.

Professor J.A. Allen remains a member of the Nature Conservancy Council and is Chairman of the Council's Advisory Committee on Science.

Professor J.A. Allen was appointed External Examiner in Marine Biology at the University of St. Andrews and in Zoology and Marine Biology at the University of Newcastle-upon-Tyne.

Professor J.A. Allen has been appointed an External Member of the Centre of Research in Aquatic Biology at Queen Mary College, London. He also acted as Chairman for session of a Conference on Marine Conservation at Stirling University on 11th June, 1987, and was a member of a CNAA visiting group to Paisley College of Technology to review the College's Science Degree Scheme.

Dr. P.G. Moore has acted as Consultant to B.U.E. Services Ltd. spending a period from 22nd-25th August, 1986 investigating novel methods of control of fouling communities on Morecambe Bay gas rigs.

Dr. P.G. Moore attended meeting of Scottish Environmental Information Network for Education (SEINE) at University of Stirling on 25th April, 1987, attended Workshop on Molecular Genetics in Glasgow University, Zoology Department, on 2nd June, 1987, and collaborated with scientists from Clyde River Purification Board in assessing the pollution impacts of whisky



distilleries on Islay, 11th June, 1987.

Dr. P.G. Moore has been invited to join (in 1988) the 'Kimberley, Australia, 200' project of the Linnean Society and Royal Geographical Society commemorating the bicentennials of the Linnean Society and of Australia and has been invited by the Systematics Association to organise a Workshop on Crustacea at Millport for August 1988.

Dr. P.G. Moore acted as Examiner for Ph.D. theses of Universities of London, Glasgow, Nottingham, and University College Cork, Eire.

Dr. R.J.A. Atkinson attended the Zoological Society of London's Symposium on 'Aspects of Decapod Crustacean Biology' in April 1987 and presented jointly with Dr. A.C. Taylor (University of Glasgow) a paper entitled 'The physiological ecology of burrowing decapods'.

Dr. V.J. Smith attended the European Marine Biological Symposium workshop meeting (organized by Dr. David Milne of the Clyde River Purification Board) on estuarine microbiological water pollution in September 1986. She also spent one week in October/November working at the British Antarctic Survey, Cambridge, looking at phenoloxidase activity and coelomocytes in branchipods (*Liothyrella uva*).

Dr. V.J. Smith spent one week at Uppsala University in January 1987 working with Dr. Joy Sturtevant on her project.

Dr. V.J. Smith took part in a short course of instruction in early June on advanced techniques in electrophoresis and protein separation (organized by LKB).

Dr. V.J. Smith visited Professor Keith Whalley, Consultant in Clinical Immunology and Head of Department in Bacteriology/Immunology, Western Infirmary, Glasgow, in July, to discuss and set up a research project on the opsonins in the prophenoloxidase activating cascade and primitive complement factors in invertebrates.

Mr. P.J. Lonsdale the Station's Chief Diving Technician acted as instructor of the World Underwater Federation's 4 star Diving Qualification. He also acted as external examiner for both the Sub Aqua Association and the British Sub Aqua Club's Dive Leader and Advanced Diver Courses.

Some thirty participants of the 9th International Malacological Congress visited on 3rd September, 1986. They were welcomed by the Director and then toured the Station and saw an exhibition of living marine molluscs of the Clyde.

A visiting group of the Highland & Island Development Board spent a proportion of their time at the Station on 25th May, 1987, while paying a visit to Millport.

As ever the Station staff have given various outside talks and lectures. These included contributions to the School of Biology, Queen Mary College; Board of Studies in Geology, University of London; North Ayrshire RSPB Members Group (Professor J.A. Allen); Millport Business Men's Club and Largs Rotary Club (Dr. R.J.A. Atkinson); and Largs Round Table Club (Dr. P.G. Moore).

#### Staff at 31 July 1987

Director: Professor J.A. Allen, Ph.D., D.Sc., F.I.Biol., F.R.S.E.  
Senior Lecturer: P.G. Moore, Ph.D., D.Sc., F.L.S.  
Lecturers: R.J.A. Atkinson, Ph.D.  
V.J. Smith, Ph.D.

#### Research

Honorary Fellow: Emeritus Professor N. Millott, M.Sc., Ph.D., D.Sc.  
Honorary Research Fellow: Emeritus Professor K.F. Bowden, D.Sc., F.Inst. P.  
S.E.R.C. Postdoctoral Fellow: Dr. Joy Sturtevant, B.Sc., Ph.D.

Research Students: S.J. Anderson, B.Sc. \*  
A.S. Downie, B.Sc.  
T.D. Nickell, B.Sc.  
R. Powell, B.Sc.  
C.J. Smith, B.Sc.  
I.P. Smith, B.Sc. \*  
K. Zainal, B.Sc. \*

\* Jointly with members of staff of Glasgow University (Drs. A.C. Taylor & F. Huntingford).

Artist-In-Residence: Ms. K. Maclean, B.A.

#### Administration

Secretary: Mr. D.J. Murden  
Assistant to Secretary: Mrs. A.T. Bain  
Cashier: Mrs. W. Anderson  
Secretary to Director: Miss M. Blackwood  
Clerical Assistant: Vacant  
Typist: Mrs. I. Sanderson

#### Library

Librarian: Mrs. N.C. Cameron, A.L.A.

#### Laboratory

Chief Technician: A.M. Elliott  
Assistant Chief Technician: Mrs. S. Barr

Technicians: Mrs. C. Lafferty  
Mr. G.F. Gale, M.Sc.  
Vacant

Laboratory Assistant: Mrs. H.N.G. Thirwall  
Diving Technicians: P.J. Lonsdale, B.Sc.  
K. Cameron

### **Specimen Supply**

Supply Officer: D.K. Cameron  
Deputy Supply Officer: R.M. Wilkie  
Technician: G. Forsyth

### **Engineer**

Station Engineer: R. Young

### **Ships' Crews**

Skipper (R.V. 'Aora'): M.J. Parker  
Mate: A. Macdonald  
Engineer: W. Sloss  
Deckhand: D. Fraser  
Skipper (R.V. 'Aplysia'): W.W. Armstrong  
Engineer/Deckhand: D.C. McLachlan

### **Domestic**

Cleaner: Mrs. C.R. Fraser  
Handy Person: H.E. McDermid  
Caretaker: G. Campbell

### **Hostel & Annexe**

Domestic Bursar: Mrs. M. Allen  
Cook: Mrs. E. Starrs  
2nd Cook/Domestic: Mrs. M. Campbell  
Domestics: Mrs. J. Shaw  
2 Vacancies

### **Visitors to the Station**

The now established practice of admitting a few selected undergraduates to work at the Station during the summer months continued. Once again we welcomed Mr. Kenneth Bruce from the Department of Microbiology, University of Glasgow, also Mr. D.W. Donnan from the Department of Zoology, University of Glasgow, Miss Ailsa Clark from Napier College and Mr. Ian Skuse from Queen Mary College, London.

Other visitors included:-

ABDUL MATIN, A.K.M. Bangladesh; ANDERSON, S. University of Glasgow; ANDREWS, C. Napier College; ASPAN, A. Uppsala University; BAKER, R. University of Manchester; BEACHILL, M.F. Fulford School, York; BELL, G.I. Wearside, B.S.A.C.; BENNETT, J.H. University of Glasgow; BENNETT, R. University of London; BETTS, A.O. Senate House, London; BINGHAM, E. Manchester Polytechnic; BOARDMAN, M. University of Warwick; BONEY, A.D. University of Glasgow; BOOTH, K. York; BYRNE, J. York; CAPARIS, M. Queen Mary College; CHARITY, R. Collins Gallery, Glasgow; CHRISTOFI, N. Napier College; CLUTTERBUCK, A.J. University of Glasgow; COCKING, K. Southport; CONLAN, K. University of Manchester;

COSSON, M.P. Villefranche-sur-Mer, France; COURTNEY, W.A.M. Queen Mary College; DEMPSTER, J. York; DIGBY, J. York; DUNLEARY, P. Manchester Polytechnic; EMSON, R. King's College; EVANS, S.M. University of Newcastle-upon-Tyne; EWEN, R. University of Glasgow; FERRY, B. Royal Holloway & Bedford New College; FIELDING, A.H. Manchester Polytechnic; FLOWERS, Lord, Vice Chancellor, University of London; FOSTER, G. University of Strathclyde; GADSBY, J. University of London; GALT, J. Napier College; GOFF, Lord, Chairman of the Court, University of London; GREEN, B. Saltcoats; GREEN, J. Napier College; GRIFFITHS, C. University of Cape Town; HAMES, C. University of Reading; HANCOCK, G. Glasgow Museum; HAWKINS, S.J. University of Manchester; HAYWARD, P.J. University College of Swansea; HENDRY, K. University of Manchester; HILL, A. University of Manchester; HODASI, J.K.M. University of Ghana; HOGARTH, P.J. University of York; HOLLEY, S. Conyers School, Yarm; HOULT, M. Manchester Polytechnic; HUGHES, R. Mechanical Engineering, University of Glasgow; HUGHES, R. Queen Mary College; HUME-KENDALL, R. London School of Economics; HUTCHISON, S. University of Manchester; INCHLEY, C.J. University of Edinburgh; JANARDHANAN, K.P. Calcutta, India; JELLETT, J. Halifax, Nova Scotia; JONES, A.M. University of Dundee; JONES, A.R. University of Reading; KELSO, D. U.S.A.; KETTLE, I. University of London; KHALID, Md. Isa, University of Malaysia; KING, J.H., H.I.D.B.; KIRKWOOD, R. University of Strathclyde; LAMPARD, S.E. King Edward's School, Birmingham; LEWIS, J. Royal Holloway & Bedford New College; LITONJUA, D.J., London School of Economics; LITTLE, C. University of Bristol; LIVINGSTONE, A. Beecham Pharmaceuticals, Irvine; MacDONALD, A.B. Dregghorn, Irvine; MacDONALD, D., H.I.D.B.; McDONALD, E.A. University of Glasgow; McILGORN, A. London School of Economics; McIVOR, F. Scottish Arts Council; MacKENZIE, C. University of Edinburgh; MacKINNON, M. Marine Conservation Society, Ross-on-Wye; McLUSKY, D.S. University of Stirling; McNAUGHTON, F. Napier College; MABEY, M. Manchester Polytechnic; MAGGIORE, M. Conyer's School, Yarm; MEADOWS, P.S. University of Glasgow; MERRYWEATHER, J. University of York; MILLER, J. Queen Mary College; MILNE, H. University of Aberdeen; MILNER-WHITE, J. University of Glasgow; MOORE, J. Henry Fanshawe School, Sheffield; MORGAN, C. Glasgow College of Technology; MULLINS, B.W. British Antarctic Survey; MURRAY, M. Collins Gallery, Glasgow; NEWELL, P.F. Queen Mary College; O'CONNOR, T. University of York; OI ZHONG-YAN, People's Republic of China; OLIVER, J. Conyer's School, Yarm; OXBROW, A. Napier College; PERRY, B. Egglecliffe School, Cleveland; PETTIGREW, M. Earlham School, Norwich; PRESTON, P.M. University of Edinburgh; RAFFAELLI, D. University of Aberdeen; RAINBOW, P.S. Queen Mary College; RALPH, R. University of Aberdeen; RAMER, B. Glasgow Museum; RAMSAY, A. University of Glasgow; READ, P. Napier College; RICHARDS, K. British Antarctic Survey; RICHARDSON, A. Marine Laboratory, Aberdeen; RIGBY, D.C. King Edward School, Carlisle; ROBINSON, J. Queen Mary College; ROGERS, E. University of Edinburgh; RUSSELL, A.P. King Edward's School, Birmingham; SANTOS, R. University of Manchester; SIMKISS, K. University of Reading; SIMMONDS, M. Queen Mary College; SIMPSON, C. Shetland Isles; SMITH, M. Maritech AB, Norway; SMITH, P. University of Glasgow; SPICER, J.I. University of Glasgow; STURTEVANT, L. & E. of San Diego, California; SULLIVAN, K. University of Miami; SWEETMAN, A. Manchester Polytechnic; TAKEDA, A.M. University of Sao Paulo, Brazil; TAYLOR, A.C. University of Glasgow; THURSTON, J. University of Strathclyde; Trett, M. Queen Mary College; TUFALL, A. University of Glasgow; WALKER, C.N. Strathallan School; WALLWORK, J.A. Queen Mary College; WARDLAW, A.C. University of Glasgow; WATERS, S. Royal Holloway & Bedford New College; WHITEHEAD, B. Rochdale Snorkellers Club; WILLIAMS, G. University of Strathclyde; WILSON, F. Art Gallery & Museum, Glasgow; WRIGHT, A. Napier College; WRIGHT, S.J. Mill Hill School, Edgware; ZHUANG, OIGIAN, People's Republic of China.

### Gifts

The Station is extraordinarily indebted for a great many extremely generous gifts and donations. Particularly to Lord Rothschild for establishing a gift under the Director's control towards the well-being of the Station. Once again the library has been significantly enhanced by gifts of journals and books from friends and past members of staff. Thus, we have received scientific books and papers from the family of the late Ted Latham, for many years Chief Technician of the Station. Professor Dodge kindly donated a copy of 'Marine Fungi' and Emeritus Professor G. Chapman and Dr. P.G. Moore large and valuable collections of reprints.

### Publications

The following papers are based on work carried out at the Station. The list does not include reviews of scientific books by members of staff nor is it our practice to list papers in press. In addition Professor J.A. Allen was a Joint Editor of 'The Environment of the Estuary of the Firth of Clyde' Proc. R. Soc. Edinb. 90:1-539.

- AGNEW, D.J., & MOORE, P.G. 1986. The feeding ecology of two littoral amphipods (crustacea), Echinogammarus piriotti (Sexton & Spooner) and Echinogammarus ootusatus (Dahl). J. Exp. Mar. Biol. Ecol. 103: 203-2154.
- ALLEN, J.A., & HANNAH, F.J. 1986. A reclassification of the Subclass Protobranchia (Mollusca: Bivalvia). J. Conch. 32: 225-249.
- ALLEN, J.A. 1987. Sir Maurice Yonge, Kt. CBE., DSc., FRS., PPRSE., 1899-1986. J. Moll. Stud. 53: 117-119.
- ASPAN, A., SÖDERHÄLL, K., & STURTEVANT, J. 1986. Dev. Comp. Immunol. 10: 624. Activation of prophenoloxidase from crustacean haemocytes.
- ATKINSON, R.J.A. 1986. Mud-burrowing megafauna of the Clyde Sea Area. Proc. R. Soc. Edinb. 90B: 351-361.
- BAILEY, N., HOWARD, F.G., & CHAPMAN, C.J., 1986. Clyde Nephrops: biology & fisheries. Proc. R. Soc. Edinb. 90B: 501-518.
- BARNETT, P.R.O., & WATSON, J. 1986. Long-term changes in some benthic species in the Firth of Clyde with particular reference to Tellina tenuis da Costa. Proc. R. Soc. Edinb. 90B: 287-302.
- BONEY, A.D. 1986. Seasonal studies on the phytoplankton and primary production in the inner Firth of Clyde. Proc. R. Soc. Edinb. 90B: 203-222.
- CHEVIS, D. & ALLEN, J.A. 1986. Studies on the open sea techniques for the farming of mussels. Univ. Mar. Biol. Stn. Millport Occ. Publ. No. 5: 1-69.

- EDGAR, G.J., & MOORE, P.G. 1986. Macro-algae as habitats for motile macrofauna. Monograf. Biol., 4: 255-277.
- MCHENERY, J.G., ALLEN, J.A., & BIRKBECK, T.H. 1986. Distribution of lysozyme-like activity in 30 bivalve species. Comp. Biochem. Physiol., 85B, 581-584.
- MOORE, P.G., 1986. A new species in the genus Grandidierella Coutiere (Crustacea: Amphipoda) from an Australian solar salt works. J. Nat. Hist., 20: 1393-1399.
- MOORE, P.G., 1986. Seaweed-associated animal communities in the Firth of Clyde with special reference to the population biology of the amphipod Hyale nilssoni (Rathke). Proc. R. Soc. Edinb., 90B: 271-286.
- MOORE, P.G., & FRANCIS, C.H., 1986. Environmental tolerances of the beach-hopper Orchestia gammarellus (Pallas) (Crustacea: Amphipoda) Mar. Env. Res. 19: 115-129.
- MORGAN, C.I., & LAMPARD, D.J. 1986. The fauna of the Clyde Sea Area. Phylum Tardigrada. Univ. Mar. Biol. Sta. Millport Occ. Publ. No. 3: 1-40.
- RAINBOW, P.S., & MOORE, P.G. 1986. Comparative metal analyses in amphipod crustaceans. Hydrobiologia, 141: 273-289.
- SMITH, V.J., & SÖDERHÄLL, K. 1986. Cellular immune mechanisms in the Crustacea. Symp. Zool. Soc. Lond. 56: 59-79.
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